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REPORT ON THE COFFEE BERRY BORER,
STEPHANODERES HAMPEI, FERR IN JAVA

BY

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Fig. 1.—Map of Java. Places visited are underlined.

REPORT ON THE COFFEE BERRY BORER, *STEPHANODERES* *HAMPEI*, FERR IN JAVA.

My recent stay in Java extended over the period from the 21st September to the 29th October. It therefore lasted almost exactly five weeks. Of this period, three weeks were spent almost entirely in a study of coffee. This study necessitated the traversing of the island from the western end where Buitenzorg, the headquarters of the Agricultural Department, is situated to the eastern end of the island where the coffee areas, both robusta and arabica, are to be found. On the accompanying map of Java are indicated the areas and places visited by me (fig. 1).

In this report, I shall deal with the question of the coffee berry borer. In a separate report, I shall discuss other questions connected with coffee cultivation in the island more especially with regard to the experimental work that is being done towards coffee improvement.

In connection with my study of the coffee berry borer, two objects had to be kept in view. In the first place, I had to ascertain definitely by means of the material taken with me whether the insects which had been provisionally identified by the Entomologists of the Departments of Agriculture in Madras and Mysore as *Stephanoderes hampei* really belonged to that species and, in the second place, I had to study the conditions under which the pest has proved serious in the past and is at present proving serious in Java and the measures that have, in actual practice, been found both economically feasible and effective in its control.

This two-fold object necessitated, in the first instance, a fairly prolonged stay in Buitenzorg where I spent about a week going into the question of identification with Dr. S. Leefmans, Chief of the Institute for Plant Diseases of the Department of Agriculture. Dr. Leefmans is an officer of very wide experience and knowledge of economic entomology in general and of the coffee berry borer in particular. He has written what must be considered as two of the ablest memoirs* on this pest that have been published (1 & 2). Moreover, none of the other Entomologists

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- *1. S. Leefmans, De Koffiebessenboeboek (*Stephanoderes hampei*, Ferrari—Coffeae Hagedorn) I. Levenswyze en Oecologie, Med. van het Inst. voor Plantenziekten No. 57, 1924.
 2. S. Leefmans, De Koffiebessenboeboek. II. Bestrijding. Med. van het Inst. voor Plantenziekten No. 62, 1924.

who has devoted prolonged attention to this pest was available for consultation. Dr. Roepke, formerly Entomologist at the Malang Experiment Station and one of the chief workers on this subject, is now Professor of Entomology in Wageningen, Holland. Dr. Begemann, his successor, is employed with a private firm and was therefore not available. Lastly, Dr. Friederichs, for six years Entomologist under the Coffee Berry Borer Research Fund, is now Professor in Königsberg, Germany. Dr. Betrem, the present Entomologist at the Malang Experiment Station had, when I visited that station, been in Java only about seven months and was, moreover, devoting his attention largely to other insect pests of coffee, especially coffee mealy bugs and the coffee twig borers.

The work of identification of the material taken with me and of giving me advice in connection with the whole question, therefore, devolved mainly on Dr. S. Leefmans and his assistant Dr. Kalshoven who is making a special study of boring beetles and of the group to which *Stephanoderes* belongs. I wish here to express my most profound thanks and appreciation of the generous and painstaking manner in which these two gentlemen dealt with the problems I presented to them. Had I not been able to obtain assistance from them, my position would have been a hopeless one.

Let me turn now to a consideration of the problems. The insect specimens which I took with me contained, along with much other material not connected with the actual damage of coffee berries and beans, a number of specimens which had been collected from bored coffee beans sent in to the Entomological Section of the Department and beetles which had been found boring into coffee berries and into other plants on coffee estates and elsewhere and which were suspected to belong to the species *Stephanoderes hampei*. After a very long and careful examination, Drs. Leefmans and Kalshoven informed me that most of the specimens undoubtedly belonged to another species of *Stephanoderes*. Two, however, could not be distinguished by them in any way from the undoubted specimens of *Stephanoderes hampei* which they had in abundance for comparison. When I state that their examination of the specimens extended, during the spare hours which they could devote to it, over a whole week and included a most careful study of the various structures under the microscope, it will indicate the care and attention given to this work. While neither of these two gentlemen considers himself a systematic entomologist and while Dr. Leefmans was extremely cautious in the expression of his opinion, still they left no doubt in my mind that they considered *Stephanoderes hampei* had invaded South India. As to the failure of our Entomologists in India to distinguish between two different species of *Stephanoderes*, Dr. Leefmans said this was quite easily understood. He instanced in this connection the case where a species of *Stephanoderes* found attacking coffee in Surinam was sent to a very

experienced worker on the coffee berry borer. This expert identified the insect as *Stephanoderes hampei* but his identification was later shown to be incorrect.

At my first discussion with Dr. Leefmans, he requested me to get for him samples of bored beans from Mysore as he said that the character of the borings would greatly help him in forming an opinion on the question of the presence of *S. hampei*. I at once cabled to the Department of Agriculture in Mysore for specimens. Through a mis-interpretation of my cabled instructions, these could not actually be placed in Dr. Leefman's hands till the day before I sailed. I, therefore, requested him to cable me at an intermediate port the result of his examination. This he did informing me that one out of the five samples sent showed borings very similar to those made by *S. hampei*. Unfortunately while dead beetles were found in some of the other samples sent, there were none in this particular sample so that the identification of the borings could not be made with absolute certainty.

If we turn to the two specimens taken by me which Drs. Leefmans and Kalshoven considered to be *S. hampei*, one of these was found by Dr. Kunhi Kannan boring into the berries of liberica coffee on the West Coast, the other was found boring into castor twigs (*Ricinus communis*), on a coffee estate in Mysore. I may say in this connection that Dr. Leefmans doubted much the possibility of *S. hampei* boring into any plant other than coffee and suggested the possibility of wrong labelling of the specimens. Since my return, I have discussed this point with Dr. Kunhi Kannan and he assures me that in his opinion such an error is out of the question.

I may point out that long before I left for Java, specimens of *Stephanoderes* and other species had been sent to the Imperial Institute of Entomology for identification. On my return, Dr. Kunhi Kannan was able to report the results from this sending. They had been forwarded by the Imperial Institute to Forstrat A. C. Eggers, the German specialist on this group, who reported that the specimens of *Stephanoderes* sent to him all belonged to another species, that is, *S. uniseriatus*. It therefore became necessary for us to send the two specimens classed by Drs. Leefmans and Kalshoven as *S. hampei* to Dr. Eggers, for examination and this has been done. Until we receive a reply from him, it will be impossible to state definitely whether we have *S. hampei* among the berry borers so far collected from coffee in South India.

It may be asked by Coffee planters and others what difference it makes as long as we have forms actually doing damage to coffee beans which is indistinguishable from that of *S. hampei*. There are two answers to this question. In the first place, *S. hampei* is the only species of *Stephanoderes* which, up to the present, has been reported as doing serious damage to coffee in any country. In the second place, the probability is that the

other species present have been here for a considerable number of years if they are not actually indigenous, in which case the prospects of their developing into a serious pest are slight.

The whole question has been one of the most puzzling I have ever encountered and the circumstances surrounding the whole subject have been as unfavourable for reaching a definite decision as could be imagined. As will be remembered, the discovery of beans identified as bored by Stephanoderes was made last May long after the harvest season was finished. The monsoon season was unfavourable for field examination and the danger of spread during the coming harvesting and carting season was great. Immediate action seemed imperative and, as is well known, that action was taken, I, personally, have no regrets for the decisions which were come to, partly at least, on my advice. Should the investigations of the next few months make it probable that *S. hampei* has not yet appeared in South India and that the forms which have been identified as *S. hampei* belong to other related species, we shall all heave a sigh of immense relief and shall be able to conclude that a particularly benevolent Providence has been watching over the Indian coffee industry in the absence of any other form of protection. Should it prove that Stephanoderes *hampei* is actually in our midst, as we have up to the present believed, we shall be in possession of practically all the information available as regards the conditions favouring its spread and the means that have proved of use in its control. This will enable us to start with an immense advantage in our research and control operations.

I shall now turn to the other questions concerning coffee berry borer that engaged my attention, *viz.*, the conditions which have favoured the multiplication and spread of the pest and the measures that have been and are being taken for its control.

In the first place, it may be stated that undoubtedly the most important natural factor limiting the increase of *S. hampei* is a long season of dry weather associated with and leading to a short crop season. I give below rainfall figures for four estates visited by me on which the damage may be estimated roughly at (a) 30-40 per cent (b) 10-15 per cent (c) 5 per cent and (d) negligible but present. (See statements appended.) The figures are not exactly comparable but I think will be useful in giving some idea of the relation between the prevalence of the pest and rainfall distribution. As will be seen, the average rainfall on the estate showing the heaviest incidence of the pest is not only decidedly the heaviest but it is also the most uniformly distributed throughout the year. With a coffee such as robusta which occupies the main portion of the estate, this means the ripening of crop in every month of the year so that the insect has almost ideal conditions for its spread. In fact, the manager seemed to have practically given up hope of bringing the pest under control.

In the second estate, the rainfall is less and is not so evenly distributed. This has been the case especially during the past three or four years which have been particularly dry ones with a dry period extending over four months. Notwithstanding this fact, the manager looked upon the pest as quite a serious one and had not been able to establish during the present year at least any diminution in correspondence with the dry season. He attributed this to the fact that the estate is surrounded by small native coffee holdings on which no measures of control are practiced. It was suggested to me by a scientific officer, with whom I discussed the question that the comparatively high infestation on this estate, during the present year, might, at least in part, be accounted for by a reduction in the crop which was only about one-sixth of that of the previous year. The same number or even a smaller number of beetles would thus give a much higher percentage infestation. This is an excellent example of the danger of attempting to correlate a single cause such as distribution of rainfall with the rise or fall of insect infestation. It further makes comparison between estate and estate very difficult.

The third estate showed, according to the manager, a still lower infestation. I had no way of judging myself as the harvest had been practically finished and as the estate was a very large one. The average rainfall here was somewhat less than that on estate b and the infestation was, I think, certainly less. In this case, however, the estate was an exceptionally well managed one, I think much the best managed of any I visited. This was undoubtedly an important factor in the reduction of infestation.

Of the three estates already referred to, two, *a* and *c*, were largely robusta although in each there were experimental plots or fields given over to the testing of different species and varieties. In the case of estate *b*, there was an extremely representative collection of different varieties and species extending over a very considerable area. Estate *d* now to be referred to, was a pure arabica estate situated on the Idjen plateau (see map, Fig 1), the only locality in Java where arabica coffee is now to be found planted on a large scale. Not only is this estate situated in an area where, as can be seen from the rainfall record, there is regularly a long dry period, but it is also much higher than the others ranging between 3,000 to 4,000 feet. It is, of course, much cooler which in itself leads to a slower development of the insect while the long dry period extending to as much as six months and the definite and restricted harvest season characteristic of arabica coffee both tend to keep the pest under control. This was, in fact, the only estate I visited on which no artificial control measures were practiced or considered necessary. It was by no means free from the pest as I satisfied myself by examination of the coffee beans in the factory. The infestation was, however,

so low as not materially to effect the quality of the coffee and I was assured by the manager that he considered control measures quite unnecessary. In connection with this and all the other arabica estates on the Idjen plateau, it was interesting and important to learn that, when the pest appeared, all the robusta coffee in the area had been carefully removed leaving only arabica. As will be remembered, I have more than once expressed the opinion before my departure to Java, that our chief danger would not be in the pure arabica areas but in the areas where arabica was grown mixed with robusta. This is not because of any superior resistance of arabica to attack when the insect is present but to the fact that the presence of robusta will undoubtedly lengthen the harvest season and thus give the insect greater opportunities of multiplying.

The figures which I have given no more than give an indication of the effect of rainfall distribution. I sought for more extensive and reliable data on the question at the Malang Experiment Station but was informed by Dr. Betrem that all the data in this connection had been taken away by his predecessors presumably to write up results and had not yet been returned. He was, therefore, not in a position to give me any extensive figures. Dr. Leefmans' second bulletin cited above has a very valuable discussion on the relation between rainfall and the spread of the harvest season. Unfortunately, however, he did not have the information necessary to correlate this with the incidence of the pest.

In this connection, it is interesting to note that in West Sumatra, where there are considerable areas of both arabica and robusta coffee, the problem of Stephanoderes control has been very much more serious than in East Java. This is universally ascribed to the fact that, whereas in the East Java coffee areas, there is a fairly definite dry season, in West Sumatra this does not exist. I was unable to visit these areas myself but was assured by Dr. Leefmans that the problem there was a very serious one indeed.

If we turn to the question of varietal resistance or immunity, there was a general consensus of opinion among all with whom I discussed the question, both scientists and practical planters, that no marked difference in this regard has been established. The apparent greater resistance or immunity of arabica coffee was generally attributed to (a) the more restricted and definite harvest season and (b) the higher elevation at which this coffee is grown and the consequent slower development of the pest. In this connection, I may point out that, in the opinion of some workers, species and varieties showing a smaller disc on the free end of the berry are less liable to attack by the borer. To this group belongs *Coffea arabica*. On the Bangelan Estate, the question of resistance to berry borer is being kept in view in connection with breeding work.

As to the present position of the pest, scientific workers and practical planters with whom I discussed the matter were of opinion that it is now by no means so serious as it was in the years 1922 and 1923. This was ascribed variously either jointly or separately to (a) the drier seasonal conditions that have obtained in Java during the past five or six years, (b) the effect of control measures and (c) the natural lessening of a freshly introduced pest after its first burst of activity owing to the action of general environmental conditions. Of these, it would seem to me that the first factor has been the most effective while the second has also played an important role. I am rather sceptical about the last reason given although it was expressed by a scientific officer who inspired me with confidence. Possibly we could find some analogy in the appearance and gradual dying down of green bug in Mysore. Just before I left, Dr. Leefmans in conversation with me expressed the fear that the coffee planters were gradually allowing themselves to be lulled into a false security, and were not using those control measures which had been established as effective. He feared that, with a recurrence of rainier years, they might experience a very serious increase in the pest, largely as a result of neglect.

In connection with an estimate of damage done, I was rather surprised to obtain a decidedly gloomier picture from the planters themselves than from the scientific officers. One manager, who estimated his actual loss at 10 per cent to 15 per cent in the way of lost crop and reduction in value, told me that, when he took into account the additional cost of the control measures, the whole would represent a 20 per cent reduction in net returns. If this estimate is correct, it is admittedly a serious matter. Of all those actually engaged in managing estates, the only one who looked upon this pest with comparative unconcern was the manager of the arabica estate mentioned above. Although most of them agreed that the pest is now not as serious as it was five years ago, they still look upon it as a decided menace to the coffee industry.

Leefmans in his second memoir on the Coffee Berry Borer which deals primarily with control measures, discusses the economic importance of the pest in 1924. He discusses the damage under two heads, namely, (a) loss of quantity including weight and (b) loss of quality. As regards (a), he found that, taking the weight of unattacked beans as 100, that of lightly attacked was 92, while that of heavily attacked was only 58. There is of course in addition to this reduction in weight an invisible loss due to attack of berries not yet ripe which usually drop off and are so entirely lost. It is very difficult if not impossible to estimate this invisible loss.

As regards (b), attack leads to a great increase in triage. He found an average of 26 per cent over three years on the estate studied by him against an average of 6 per cent during the years

prior to the appearance of the pest. The General Agricultural Syndicate gave the following report of conditions on coffee estates in East Java in 1922 *re* the height of the infestation. "The infestation on the slopes of the Kloet and the Kawi (two volcanoes in East Java around which many of the robusta plantations are found) is already so heavy that a loss of crop from 10 per cent to 20 per cent has resulted. But that is not all. The price of the product that is not lost is markedly reduced as a result of the infestation; so the prices given in market reports are misleading. They give the impression that the coffee can be sold at prices similar to those quoted but this is usually not the case. The prices are for fair average quality but this supposes that no beans are bored whereas actually on some plantations 50 per cent are attacked, so obviously the producers cannot sell at these prices. They must put the crop on the market as unsorted robusta which leads to a reduction of 3·50 guilders in the price per picol. But this again is not all: for there is a further reduction in price on account of the borer attack itself. Taking this into consideration, we come to the following position whereby we must not forget the primary loss of 10 per cent to 20 per cent of the crop through the borer.

If we suppose that fair average quality sells at f. 30 per picol, then for unsorted coffee the price is f. 39 - f. 3·50 = f. 35·50 per picol. Suppose this coffee has an attack of 25 per cent (which is moderate), then a reduction of 12 per cent would result in the price on this account plus f. 1·50 per picol for sorting expenses or a total of f. 5·94. This would bring the price down to f. 29·56 per picol or almost f. 10 per picol less than that given in market reports."

I may point out that now all the coffee is sorted on the estates and the bored beans are carefully removed. This was being done even on the arabica estate I visited. A limit is usually fixed in the sales contract for bored beans. Usually the presence of more than 5 per cent of bored beans in a consignment leads to a reduction in price but in seasons when the supply of coffee threatens to exceed the demand, the limit may be fixed as low as 2 per cent. The possibility of sorting coffee on estates is, of course, bound up with that of the complete preparation of coffee for the market, something which is done (as far as I could gather) on every estate in Java. I shall deal with this question in my report on coffee cultivation but may point out here that this enables a much more thorough control of spread than would be possible in South India under present conditions.

If we now turn to control measures against the Coffee Berry Borer, opinion has by now pretty well crystallised on the methods that are and are not practicable. In the first place, I must refer to the attempt made to introduce from Uganda a parasite to control the pest. As is well known, attempts were made to introduce two parasites of *S. hampei*, viz., *Heliospilus coffeicola*

~~and~~ *Prorops nasuta*. Experiments on the introduction of the latter were unsuccessful, so only the latter was actually used. It was released from the beginning, more especially by Leefmans, ~~that~~. *Prorops nasuta* was likely to furnish a much less effective parasite than *Heliospilus coffeacola* mainly for two reasons, firstly, while *Heliospilus coffeacola* leaves the brood chamber and flies from berry to berry thus parasitizing the brood in a number of berries, *Prorops* confines its attention to the brood in each berry. In the second place, *Heliospilus* has been found attacking brood in green and ripe berries in addition to that on the black berries. *Prorops*, on the other hand, has been found attacking brood in only the black berries.

The actual experiments with *Prorops nasuta* which extended over a period of five years and which involved large scale rearing and distribution of the parasite have ended in failure. The parasite has not been able to control the pest in any way and, in fact, has not been able to hold its own on estates where it was introduced. It seems gradually to decrease in numbers under the conditions existing in Java and it has been very rarely recorded on estates where it has been liberated. All efforts to multiply and distribute it have ceased.

The reasons given above would perhaps be sufficient to account for the unsuccessful introduction of *Prorops nasuta* into Java and Sumatra. There is, in addition, another factor which should not be ignored. The climate conditions in the coffee areas of Java and Sumatra are very different from those of the robusta areas of Uganda. It is quite possible that the difference in these conditions has had a good deal to do with the failure to establish *Prorops* in Java. The climatic conditions in the coffee areas of South India are, I believe, much nearer those in Uganda than in the Java conditions, so it is possible that we might have better success with *Prorops* than the Dutch have had. Their attitude should, I think, not deter us from making an attempt here but the investigations of the next few months make this seem advisable.

The Dutch have not given up all thought of using parasites to control *Stephanoderes* and are still attempting to introduce *Heliospilus coffeacola* from Uganda. Up to the present, however, their efforts have not been successful.

It would, I think, be out of place in this report to refer to all the measures that have been attempted in connection with the control of *Stephanoderes hampei* in Java and Sumatra. Many of these are now of no practical interest as they have been discontinued. All the measures that are now being used have to do with the reduction in numbers of the pest by the treatment of the red berries immediately before and during the harvest and the establishment of a definite period, if possible, of at least three months, during which no berries are on the trees large enough to furnish breeding and multiplication ground for the

beetles. Along with methods to this end, is recommended an examination and statistical recording of infestation on estates so as to enable the estate management to judge of the severity of attack and to decide upon the nature of control measures which are to be undertaken. The accompanying form, which I owe to the kindness of Dr. Betrem, Entomologist of the Malang Experiment Station, shows the method of tabulating the observations.

Results of an investigation of coffee berries attacked by the berry borer (observations on a sample of 500 berries taken at random through each division of an estate amounting to approximately 300 acres).

Berries	Green		Red
	Hard	Soft	
Uninfested
Attacked
Borer not present
Borer present
Brood present
1. Bean attacked
2. Beans attacked
Total
Percentage hard
1. Apparent attack
2. Real attack
3. Serious attack

1. "Apparent attack" denotes borer present but no borer.
 2. "Real attack" denotes borer present.
 3. "Serious attack" denotes borer and brood present in hard beans.

Instructions are to commence the recording 4 months before the beginning of harvest and to make observations every month or every two weeks where the attack promises to be severe. The making of these observations is, I believe, fairly general on coffee estates in Java although Dr. Betrem informed me that by no means so many records were sent into the station as they would like to have. I learned that a number of companies objected to divulge, even to the Experiment Station, information in this connection.

Dr. Betrem also very kindly gave me full particulars as to the methods of control recommended by the Malang Station and carried out more or less thoroughly by the planters themselves.

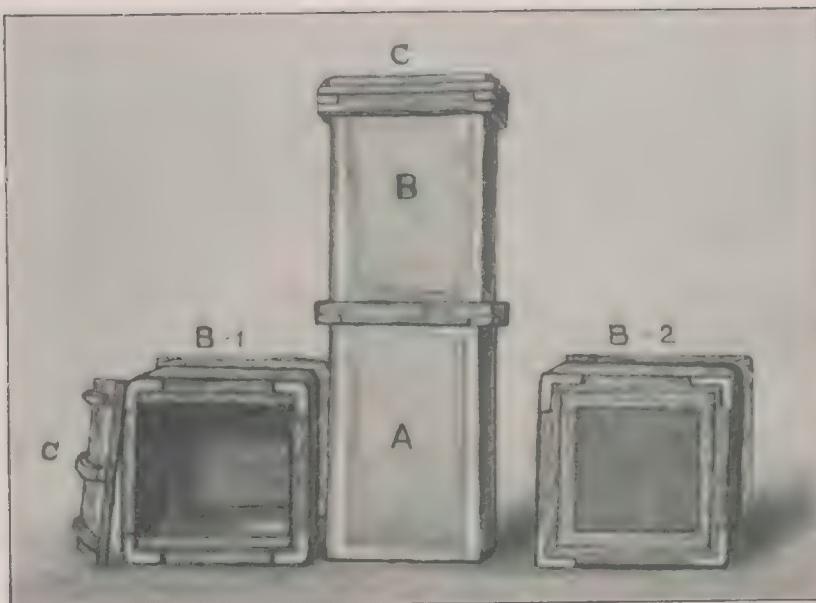


FIG. 2.—Steaming apparatus for central of coffee berry borer. A. Vessel for water. B. Container for coffee borer. C. Cover B-1 Container from above. B-2 Container from beneath.

1. The picking of all fallen berries which should begin two months before the commencement of the harvest. These berries are caught in and steamed at the factory in a way to be described.

At the same time, all red berries on the trees are picked by one person and steamed in the same way. This treatment, however, necessitates, as a preliminary step, clean cultivation.

2. At harvest, the pickers are provided with two sacks. In one, they pick the ripe berries from the trees; into the other, the unripe berries and black berries from the trees. The picking should be completed every two weeks if possible, and this should be insisted upon in cases where infestation has been known to be heavy by previous sampling. The berries from the trees and black berries from trees should be steamed as above. This should be done at the factory and not in the estates, as it is difficult, if not impossible, to provide adequate supervision in more than one central place.

3. The final picking (stripping) which is likely to contain the greatest quantity of infested berries should be steamed.

As regards the methods of treatment for killing the insects, both boiling the berries in water and steaming over water are practised. In the former case, the treatment should last 2 to 3 minutes; in the latter case, 10 minutes. Steaming seems to me a method much more easily controlled, as the water in the generating vessel can be kept steadily at the boil, while, where berries are put into hot water, it will take some time to heat up again and the exact time of boiling will be harder to gauge. The apparatus for steaming consists of two ker side tins, one for the water and one for the berries. The latter, which has its bottom replaced by a coarse and heavy wire gauze, is held in place by wooden strips fastened inside and outside. The outside strips project so as to fit over the top of the lower vessel which is supported by finer wooden strips fastened on the inside. The steaming vessel is, of course, covered with a wooden top to hold in the steam. Figure 2 gives different views of a steamer used for this purpose.

Dr Betrem assured me that a battery of twenty of these steamers could be kept going by one man. He can, in other words, finish a round in 10 minutes. I need hardly point out that treatment for a longer period than that mentioned is likely to affect the colour of the coffee.

As regards the treatment of the red berries which go to the pulper, it is generally considered that a period of from 24 to 48 hours under water in the fermentation vats is sufficient to destroy most, if not all, beetles and brood. No special treatment is given to the pulp. Machinery is in existence in the form of a special peeler and washer which does away with the necessity of fermentation and thus greatly shortens the time before drying but this requires a large amount of power and has not come generally into use.

The machinery used on coffee estates will be described in a separate report on coffee cultivation. It must, however, be noted here that the practice universally followed in Java of drying parchment coffee in drying houses on the estates themselves seems pretty well to exclude the possibility of transporting live beetles in the coffee as tracer from the estates. This drying destroys practically all, if not all, the beetles and brood that may be alive after the previous treatment.

Before leaving this question, it is interesting to note in the combined coffee and rubber estates which are quite a common feature in East Java, dusting experiments have recently been undertaken for the control of malawis and rubbers. A good deal of sulphur used in dusting has, of course, fallen on the coffee trees underneath and this has according to my information led to a diminution of coffee borers including the berry borers and the twig borers (*Xyleborus* spp.). This has led some of the planters at least to hope for a control of the coffee berry borer through dusting with some form of dust and, in fact, one manager informed me that he was carrying out experiments in this direction and had considerable hopes of success. However, he would not let me know the nature of the experiments nor the kind of dust he is using. I discussed this question with Dr. Beerensteyn, particularly as he is devoting much attention to the twig borers. He admitted the effect that the sulphur dusting had shown but expressed the opinion that, as it simply drives off the borers it does not actually kill any, the probability is that, should dusting become general, the beetles would get used to it and the deterrent effect would disappear.

If we now turn to the question of control in South India, it may seem somewhat premature to discuss this before we know definitely that we have among the species of *Stephanoderes* which are undoubtedly present on coffee estates in South India, *Stephanoderes latipes*. However, I believe it would be well to express my views here in regard to this question. In the first place, as already stated, we are in most if not all of the areas in South India definitely in a favourable position as compared with Java and Sumatra. We are also favoured in that our main coffee crop is still arabica and the harvest season of this variety is short. The fact, however, that robusta has, in recent years, been planted to a steadily increasing extent and the further fact that it would be impossible, even were it advisable, to have all our robusta uprooted undoubtedly makes the situation a more serious one. As far as one can see, there are certain of our areas in which robusta will gradually replace arabica unless we can produce a more vigorous arabica selection or a vigorous hybrid to plant in these areas. We have also the possibility of extending coffee cultivation into entirely new areas through the planting of robusta, a possibility which, I believe, is by no means remote.



FIG. 3.—Coffee drying house, Wonokoio Estate.

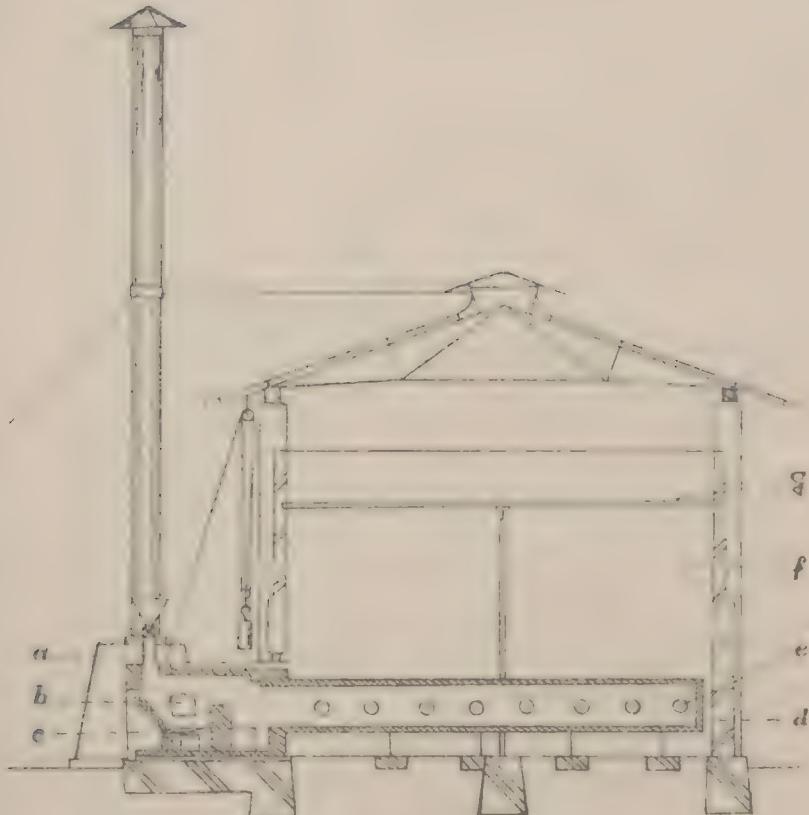


FIG. 4.—Cross section of coffee drying house showing furnace and combined flue and heating pipes. Scale 1 to 100. *a*. Feed funnel for coffee hulls. *b*. Furnace door for wood. *c*. Fire grate. *d*. Combined flue and heating pipe. *e*. Cross pipe. *f*. Air chamber. *g*. Drying floor of perforated iron plates.

The difficulties caused by the presence of many small holdings where the introduction of control measures will be great, exist in Java and Sumatra to as great an extent as in South India. In fact, I believe our situation in this regard is better than theirs. As far as I could gather, very little serious attempt has yet been made in Java to improve the so-called native cultivation beyond the supply of seed of improved varieties. The large European companies in Java, through their separately owned and maintained experimental stations, seem to have severed themselves pretty completely from the native growers and, as far as I could see, show no inclination or desire to help them. The Agricultural Department have, it is true, a staff for the purpose but I do not believe this work is as well organised as is the similar work in Mysore, for instance. The fact that the work that is being done for the improvement of coffee in South India is being appreciated just as much by the Indians as by the European planters will, I believe, make the introduction of control measures, even among small Indian planters in Mysore, succeed well within the realm of practical politics. I should not be surprised if within the next few years the organisation of more extensive experimental and demonstration work, leading as I think it must, to a steadily increasing association of Indian and European planters, might not prove an important factor in securing these adjustments of relationships which will be necessary under the changed political conditions which are certain to arise.

Finally, there is one feature of the Coffee Industry in South India which will undoubtedly favour the spread of the pest. I refer to the final drying and preparation of coffee for the market by certain firms who deal with crop of many different estates and whose works are situated many miles from the estates themselves. Coffe semi-dried on the estates as is the practice in South India would undoubtedly carry live beetles and brood; the danger of spreading the pest on bags from the curing works has been emphasised on more than one occasion. While the first step to prevent this would be the fumigation of the bags at the works, an operation which is quite feasible, it must, I think, be clear that the complete drying of coffee on the estates would be a much more satisfactory safeguard.

The difficulties in the way of drying on the estates are mainly those of the extra capital involved. I was informed that a single drying house such as that illustrated in the accompanying photograph (Figures 3 and 4) would cost between 10,000 and 14,000 guineas or roughly Rs. 11,000 to Rs. 20,000. This would, however, be too large for any but our larger estates, but the cost of the drying operations would be comparatively small. The staff required is about 6 or 7 coolies and the fuel would probably be provided from the estate. The rotary driers used in America are not employed owing to the cost of operation.

I obtained information in regard to a much smaller and cheaper drier on the pattern of a maize drier used in America. An Engineer in Malang said he believed he could construct one of these for about 5,000 guilders. I propose taking up the question of designing a drier of this sort to suit our conditions and if funds can be made available, we shall have one erected on the coffee station. While the primary object of such a drier would be the control of the coffee berry borer, I believe that irrespective of this, the experiment is worth trying. I shall go into this question more fully in my separate report on coffee cultivation.

Turning to the question of fumigation of bags, I discussed the matter thoroughly with Dr. Leefmans. He was of opinion from very considerable experience that the only feasible method would be the use of steam or fumigation with carbon-bisulphide. Hydrocyanic acid has proved quite ineffective against the coffee berry borer; so it must be discarded.

The use of steam would involve the presence of a boiler and a special steaming chamber. If these were available, it would probably be the cheapest method. The length of time required would have to be worked out by experiment: for, as far as I was able to ascertain, this method has not been tried in Java for bags and of course, the small steamers described above would be unsuitable.

It would appear that fumigation with carbon-bisulphide is the most feasible method of treating bags. Dr. Leefmans told me that a dose of 40 c. c. of CS per cubic metre for 24 hours at a temperature not below 75° Fahrenheit had proved quite satisfactory against coffee berry borer. If the temperature drops below 75°, a stronger dose would be required. The above dose, when translated into the measures used by us, represents about 23 lbs. per 1,000 cubic feet. I have requested Dr. Kunhi Kannan to ascertain by a trial just what this is likely to mean in cost and he informs me that at the present price of CS (about 6 as. per lb.) this would represent a cost of approximately 1 pie per 35 bags. Dr. Leefmans pointed out that no elaborate fumigation chamber is required where CS is used. In fact, for the fumigation of coffee at the Institute for Plant Diseases, they were using a simple wooden box with a cover that could be screwed on (See Figure 5). The joints of the cover were made tight by means of a strip of rubber along the edge of the box. If the box is not made tight by using tongue and grooved boards, the cracks can be covered with several layers of good paper pasted on. For large quantities a room with a tight ceiling would be required. This should, of course, be without windows and the door which should fit tight should have the cracks well covered with paper pasted on. I need hardly remind readers that as carbon bisulphide vapour is heavier than air, the liquid should be placed in a receptacle close to the ceiling. A tray fastened to the ceiling by wire would be suitable.

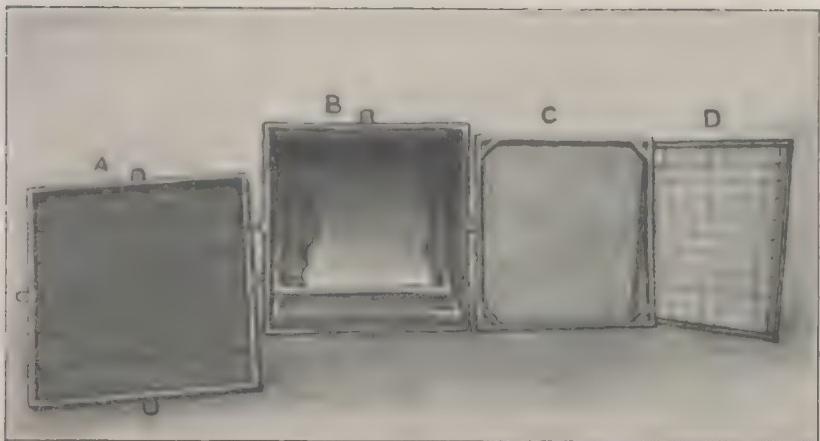


FIG. 5.—Wooden box used for fumigating coffee with carbon bi-sulphide.

There is a certain amount of danger in the use of carbon bisulphide as it is inflammable and a mixture at certain concentrations with air is explosive. Dr. Leefmans considered that, with ordinary care, the danger from its use is practically nil. He informed me that in all the years they had used it as a fumigant, they had had no accident.

As regards fumigation for seed purposes, it has been found that while carbon bisulphide has, at times, given satisfactory results, at other times, its use has led to a serious loss of germinating power. The cause for this is not known but to avoid this danger, it became necessary to discover some more satisfactory fumigant for the purpose. This has been done by Dr. Begemann in the form of Turpentine.³ Dr. Begemann's method of coffee seed fumigation as practised by the Institute for Plant Diseases, Buitenzorg, at present is as follows:—

The fumigating box is a wooden box, as shown in Fig. 5. The edge of the opening in the box is covered with a cushion of rubber against which the box cover is pressed by means of two clamps which can be screwed tight. The coffee is placed in trays about two inches deep and with a bottom of coarse wire gauze. When the coffee has been filled into the bottom tray, a frame is placed over it on which a coarse cotton cloth soaked with turpentine is placed. Trays alternate with frames covered with these cloths till the box is full. The fumigation extends continuously over 72 hours when the box is opened.

Since my return from Java, I have received a copy of Dr. Begemann's latest article on the fumigation of coffee seed.⁴ From this publication, I translate somewhat freely his latest directions for the fumigation of coffee seed with turpentine.

"For the freeing of coffee seed from berry borer (*Stephanoderes hampei*) through fumigation with turpentine, a receptacle as, for example, a galvanized iron box of $1\frac{1}{2}$ ft. X $1\frac{1}{2}$ ft. X 1 ft. (sufficient for about 1 cwt. of seed) or an iron drum covered with a top which can be tightly closed is necessary. The bottom of this receptacle is covered entirely with a coarse cotton cloth which is moistened with one cubic centimetre of turpentine per 100 square centimetres of cloth. On the cloth, a layer of coffee seed not thicker than five to seven c. m. (about two to three inches) is placed and this is covered by a second cloth moistened in the same way. For convenience, the space to be covered by each layer of coffee is marked on the inside of the box. According to the amount of coffee to be fumigated, there will be one or more layers of coffee. The top layer is covered with a cloth moistened with turpentine as above.

³ H. Begemann, Nieuwe Methoden voor de Ontsmetting van Koffiezaad, I. Med. van het Proefstation Malang, Archief voor de Koffiecultuur 1926, pp. 208-216.

⁴ H. Begemann, Nieuwe Methoden voor de Ontsmetting van Koffiezaad, II. Med. van het Proefstation Malang, Archief voor de Koffiecultuur October 1926, pp. 45-55.

If there is no special arrangement for closing the lid of the box or drum hermetically, the edge should be covered with thick wrapping paper tightly pasted on. After 72 hours' fumigation, the box is opened and the seed is aired in a place away from the sun for a period of two or three hours. After this it is mixed with 30 per cent of its weight of dry finely powdered charcoal and kept in boxes or tins. Where there are openings in the top of the tin or box for ventilation purposes, these should be covered by fine bronze wire mesh about 40 meshes to the inch which should be tightly soldered on. This will prevent reinfestation of the seed by berry borers coming from outside."

Finally, I must refer to the question of importation of coffee into India. Whether the next few months shall prove that *S. hampei* has already invaded South India or not, I consider the case for prohibition of imports is a very strong one. The coffee industry, under present conditions, can hardly sustain any extra loss or extra expense in connection with combative measures in addition to what it at present has to bear. Dr. Leestmans attempted to impress upon me the thoroughness and care exercised over the fumigation in Java and indicated that, under present conditions, there would be no danger from imports from Java. Even were this so, so much coffee reaches us *via* Singapore that any protection that fumigation practised in Java would afford, would be of little value. Dr. Leestmans could, in this connection, naturally hardly speak as an entirely disinterested party and, while I have a high regard for him, I regret that the evidence of my own eyes prevents my agreeing with him. The only fumigation of coffee that I actually happened to see while in Batavia was not being carried out according to the above directions and in fact, through lack of adequate supervision, was being done in a quite unsuitable manner. If this is not enough, I have still another example of the danger of trusting to certificates of fumigation. Seed of selected varieties of various annual crops (among them maize, soy beans and paddy) have been received from Java since my return to Bangalore. Although these were accompanied by a certificate of fumigation bearing the signature of Dr. Leestmans (put on with a rubber stamp), two lots of maize seed were found heavily infested with live and very active weevils. The fact that these happened to belong to a species common here in no way weakens the evidence that the presence of a fumigation certificate of this kind in no way guarantees freedom of the shipment from live insects. Only careful and vigilant inspection at this end could ensure that and as everybody knows, such inspection of large quantities of coffee would be out of the question.

II

Other Pests and Diseases of Coffee in Java.

If we exclude the Coffee Berry Borer, the main insect pests of coffee in Java are the coffee green bug (*Coccus viridis*), coffee mealy bugs, chiefly *Pseudococcus citri* and *Ferrisia* (*Pseudococcus*) *virgatus*, and the various coffee twig borers of which the most important are *Xyleborus marginatus* and *Xyleborus morstatti*. The coffee white borer (*Xylotrechus javanicus*) is not looked upon as a pest and most planters with whom I conversed, even those who were or had been engaged in planting arabica coffee, had never seen one. When we consider that arabica as well as other coffee in Java are grown under much lighter shade than is used in South India, this seems rather remarkable. The question of the relation of the white coffee borer of Java to that of South India is an interesting one. Both Dr. Leemans and Dr. Kalshoven are of opinion that they are probably one and the same species although ours is given another specific name, *X. quinipes*. The type of damage as exhibited in museum specimens which I saw in Java is identical with that so well known here and to the eye of one who is not a systematic Entomologist, the insects appear identical. The question is of some practical importance, for if they belong to the same species, it would be important to learn whether this pest does serious damage in South India and not in Java. The somewhat higher elevation at which arabica coffee is planted in Java may have something to do with it; for here also coffee borer is usually not a serious pest at higher elevations. The presence in Java of parasites more effective than those found in South India might possibly have something to do with the difference. The question is one worthy of further investigation and as I was able to bring back with the specimens of *Xylotrechus javanicus*, the question will be gone into.

Turning to the more serious pests of coffee in Java, the following notes may be of interest.

Greenbug. This is considered quite a serious pest notwithstanding the fact that what are apparently the same two fungi that are active in its control in South India are also found in Java. The one artificial method of control is the trapping of the chief ant species (*Plagiolepis longipes*) responsible for its distribution in artificial nests placed in the ground. This very ingenious control method is due to Dr. Van der Goot, the leading authority on this insect. Unfortunately for us, this method is not of much use in South India as *Plagiolepis longipes* is not one of the chief factors in distributing green bug here. As is well known to South Indian planters, the destruction of the several species of ants active in spreading green bug is one of the

Blackrot caused by *Cercospora koleroga* has been reported from Java but does I believe, very little damage. As is well known, it is much less severe on robusta coffee than on arabica in India. Two other somewhat similar diseases which are of importance in Java but which have not been found attacking coffee in South India are the so-called "Spider web disease" caused by an unnamed fungus and the so-called "Djameer Oepas" caused by *Corticium javanicum*.

Finally a new and apparently serious disease has recently appeared chiefly on robusta coffee in both Java and Sumatra. This is the so-called "Topsterne" or Top Die Back. This is distinct from the Die Back diseases of South India and East Africa. It is forming the subject of quite intensive study at present. It is not yet known whether it can be carried by seed but to prevent the possibility of spread in this way no coffee seed is sent from areas affected to areas where the disease has not yet appeared. The cause of the disease has not yet been established but a species of *Leucostoma* has been found generally associated with it.

As regards root diseases, they are by no means unknown in Java but on no estate that I visited were they considered serious nor did I find that any control measures were looked upon as necessary in connection with them.

There are of course many other pests and diseases of coffee known in the Dutch East Indies but they are apparently of minor importance; so I need not refer to them here. On the whole, I think we may say that the Dutch East Indies coffee planters have just as many and as serious pests to contend with as have the coffee planters of South India. As already pointed out they have not yet seriously attempted to control any of these pests or diseases by means of spraying.

III

Note on the Berry Borer situation in India by Dr K. Kunhi Kannan.

An examination of over 290 samples of coffee obtained from Curing firms or direct from the estates had been made from June to August. This was followed by the examination of young berries in several of the estates in Mysore and Coorg to which infection had been traced. The young berries attacked by S. hampei turn black and it was believed that such berries on the estates would on examination yield evidence of the existence of the pest. But no beetles or signs of attack by them were found except in one case in which a beetle was obtained. This beetle is certainly *Stephanoderes*, but whether it is hampei or not has yet to be determined. The black colour of the berries was due to fungus disease of one kind or another. The decay resulting from it had attracted to them flies of which maggots were found in several.

With the close of the monsoon dry berries began to be noticed on the bushes and the examination of these revealed the presence of three species of beetles.—

One large form which does not belong to the *Stephanoderes* group.

One very small species looking very much like *Stephanoderes* but clearly belonging to an allied group *Hypothemus*.

One which is clearly a *Stephanoderes*. Whether it is hampei or not has yet to be determined.

These three species have been found both in Mysore and Coorg. None of these, however, have so far been noticed to bore into the bean. They enter usually through a hole bored into the disc but rarely at the side or from near the stalk. Eggs and larvae have also been obtained but always in the fleshy portions of the fruit, more especially between the seeds. It is likely that they may be found to attack the beans themselves but so far they have not been observed to do so.

Beetles looking like *Stephanoderes* have been looked for in bark, branches and seeds of other plants met with in estates. Of these, one from castor comes closest to hampei. About 124 specimens in 14 lots including the one on castor have now been sent to London for identification.

The investigation in the field now is concerned mainly with the collection separately, at fixed intervals, of dry berries on the bushes and of those fallen below, from two estates with a view to their examination for beetles. It is believed this work is being done in Coorg also, where an Assistant from this Department was on deputation for 4 months to investigate the pest and train two local men for it. It is planned also to study the variations in

hampel and related species. From the various species examined, it appears probable that individuals within the same species have a wide range of variation. The limits of these have to be determined. To do so it is necessary to carry out rearing experiments and these will be taken on hand as soon as possible.

As soon as gleanings are gathered, an examination will be made of samples from estates from which samples of last year's crop were examined. This would help us to find out whether or not the percentage of beans believed to have been attacked by *Stephanoderes* has increased. Owners of all estates who sent in samples for examination are requested to send samples in the next crop. Curing firms are also requested to co-operate with us in this work.

It will be seen from the above that work is proceeding on the assumption that the pest exists in South India. Whether the assumption is correct or not depends on the identification of the species sent to London. If one or other of these is declared to be hampel, the work so far done will form a most useful basis for further investigation.

STATEMENT "A"

Rainfall from 1919 to 1930 at Bajoe Kedoe Estate in inches.

Months	Average Daily Precipitation in inches.											
	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
January	18.96	14.05	16.7	16.3	20.38	17.1	13.06	12.94	14.08	22.64	9.84	29.46
February	22.5	16.74	17.6	22.8	14.09	11.5	9.45	16.44	17.67	20.13	11.17	17.43
March	10.5	9.35	23.3	16.4	23.2	16.28	10.7	17.95	15.56	14.20	15.75	10.98
April	14.2	16.4	6.5	9.75	10.0	12.4	12.32	9.57	10.20	13.58	.90	9.67
May	27.6	11.25	2.25	16.6	14.58	17.68	2.6	7.17	12.41	6.89	.98	27.16
June	7.8	25.8	14.85	23.0	13.85	14.93	16.14	7.17	12.53	22.77	20.75	3.50
July	3.1	23.2	11.3	16.5	27.44	5.98	10.47	3.26	10.94	11.72	8.47	8.47
August	1.74	50.00	10.1	3.95	1.78	2.90	8.3	6.85	1.66	14.97	4.25	6.20
September	8.7	13.14	11.6	4.15	.63	6.12	7.21	5.33	.54	4.37	4.76	.95
October	2.36	16.14	19.0	14.81	1.93	24.05	1.30	1.62	1.18	9.96	1.18	...
November	12.8	11.85	21.4	3.26	1.94	38.15	7.23	6.39	23.47	21.0	2.80	...
December	21.8	17.20	20.5	19.4	11.96	2.52	16.59	28.60	18.64	27.32	25.00	...
Total	146.55	225.12	171.1	166.02	141.18	169.56	110.47	128.29	140.98	169.55	105.85	118.17

STATEMENT "B."

Rainfall in inches at the Government Coffee Estate "Bangelan" (Java); Figures for the years 1919—1929.

Months	Rainfall in inches																						
	1919	1920	1921	1922	1923	1924	1925*	1926	1927	1928	1929												
January	12.98	16	18.60	25	11.68	17	20.24	28	9.52	19	15.96	21	...	...	...	10.04	26	22.12	26	7.88	15
February	13.72	19	15.08	18	10.19	19	4.36	12	9.56	22	9.00	22	...	...	...	10.16	15	10.52	19	7.04	18
March	9.88	12	13.88	20	12.64	21	19.04	23	5.64	11	18.60	21	...	...	...	15.08	21	11.96	16	24.60	25
April	11.92	15	14.66	21	5.36	11	13.44	12	10.28	13	7.52	15	...	...	7.72	13	9.00	11	10.84	17	
May	14.44	16	.96	4	2.88	4	17.16	14	6.92	8	3.08	9	...	...	10.96	13	2.16	8	3.36	5	
June	1.48	6	4.40	8	3.72	5	6.76	11	6.44	9	.98	8	...	...	...	7.00	12	8.28	9	.48	1
July92	8	8.06	2	.66	4	9.44	13	.40	8	...	...	...	...	...	...	...
August08	1	4.62	14	3.56	4	...	...	...	...	...	...	...	...	...	.76	4	.16	8	6.24	7
September	1	7.96	12	1.04	7	...	...	...	...	...	...	...	...	1.48	4	1.08	4	.48	1
October	28	1	7.20	17	7.88	13	5.68	9	...	19.48	17	...	...	.60	4	6.68	9	.44	8
November	14.64	18	12.84	19	8.20	11	8.20	16	6.32	10	20.12	23	...	...	15.08	15	7.80	12	12.16	18	
December	25.56	26	6.48	16	18.20	19	28.04	25	7.44	16	3.76	18	...	...	20.08	28	11.96	17	16.08	25	
Total	...	104.36	...	107.40	...	88.36	...	116.68	...	71.76	...	98.60	...	...	...	56.68	...	81.12	...	102.68	...	64.64	...

*No records are available for this year and for three months in 1926.

STATEMENT "C".

Rainfall from 1920 to 1930 up to date, Malangarie Estate.

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Months	1920		1921		1922		1923		1924		1925		1926		1927		1928		1929				
	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	
January	...	17	14-12	15	10-0	20	12-94	15	10-12	16	7-49	25	12-16	20	11-73	25	13-20	25	16-22	25	10-16	18	6-93
February	...	20	15-83	17	15-60	16	7-26	21	14-81	31	12-32	17	11-97	20	12-76	16	6-44	20	16-02	15	8-30	25	12-60
March	...	18	19-10	19	12-52	18	8-71	18	6-51	18	8-67	20	4-49	23	17-48	22	11-84	21	15-60	24	20-04	21	12-64
April	...	19	15-09	3	63	17	16-31	11	8-47	13	6-90	19	12-04	17	4-21	14	5-54	14	7-41	10	8-04	18	5-8
May	...	6	4-53	4	.59	28	17-96	17	10-56	17	11-09	8	8-95	11	6-00	16	6-86	10	1-50	1	.04	17	4-88
June	...	11	10-70	16	7-41	23	14-39	9	6-04	12	5-50	12	2-80	8	.98	14	15-13	16	8-47	7	4-49	6	.59
July	...	18	10-62	11	4-53	14	4-61	20	15-87	8	2-40	11	4-25	6	.35	10	4-49	18	8-24	8	.44	13	4-17
August	...	21	17-89	10	4-57	3	.67	5	.19	5	.51	6	.55	9	2-63	3	.40	12	5-33	4	.23	6	1-62
September	...	13	12-48	10	4-37	3	.76	1	.04	12	1-46	8	3-10	12	2-72	7	1-34	7	.94	6	1-02	1	.16
October	...	13	14-24	10	5-66	16	7-29	7	8-95	18	12-74	2	.12	3	.67	5	1-78	9	3-47	2	.28	..	..
November	...	14	16-30	14	9-96	10	4-26	6	1-97	29	19-32	7	1-64	8	3-34	19	7-49	10	2-80	5	5-00	...	..
December	...	10	6-28	16	12-82	25	22-96	19	15-13	12	3-91	17	14-65	27	16-06	19	11-21	24	20-42	18	8-94	...	...
Total	...	157-5	88-16		118-08		93-96		91-41		78-94		71-62		86-7		96-42		61-36				

STATEMENT "D".

Rainfall in Inches in Kalisat Estate from 1919 to 1929

Months	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929
January	9.14	13.81	8.87	9.35	29.00	10.13	8.55	14.08	9.84	8.51	10.93 Lockes
February	27.56	15.01	29.96	11.65	8.20	10.60	8.91	11.01	10.48	10.32	4.80 do
March	7.05	4.76	11.85	7.69	11.45	4.80	6.89	12.68	11.04	20.10	8.07 do
April	6.82	6.73	8.42	5.48	7.88	3.62	8.61	4.68	8.26	9.08	1.16 do
May	1.46	1.60	6.65	12.36	8.76	...	6.97	4.84	1.08	...	...
June	...	...	1.40	1.30	5.40	1.04	1.00	.48	8.26	2.80	do
July	2.76	...	...	10.63	...	...	28	...	...	...	...
August	2.28	3.08	6.60	...	...	...	7.08	...	...	...	...
September	...	...	1.20	...	...	...	0.08	...	...	...	...
October	...	...	5.40	1.08	2.23	...	3.04	...	...	7.2	1.80 ...
November	8.66	6.65	2.68	8.88	8.00	18.85	...	2.44	8.66	8.82	...
December	6.73	11.33	9.10	7.50	2.80	7.05	31.00	11.73	9.92	12.44	do
Total	60.74	67.59	71.79	52.33	88.77	63.51	41.19	83.84	53.88	69.66	40.20 do